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10, pt. 1

MINUTES AND PROCEEDINGS

of the tenth meeting of the

ARMY - NAVY - OSRD VISION COMMITTEE

13 March 1945

National Academy of Sciences
Washington, D. C.

COPY NO. 168

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Lt. Col. F. S. Brackett	7
Dr. Charles W. Bray	8-10
Lt. S. H. Britt	11
Dr. Detlev W. Bronk	12
Lt. Comdr. R. E. Burroughs	13
Lt. A. Chapanis	14
Comdr. Oran W. Chenault	15
Major O. P. Cleaver	16
Capt. Howard E. Clements	17
Lt. Col. R. S. Cranmer	18
Mr. John E. Darr	19
Capt. Jack Davis	20
Col. G. F. Doriot	21
Dr. Theodore Dunham, Jr.	22
Lt. Comdr. H. G. Dyke	23-24
Lt. Comdr. George W. Dyson	25
Major R. R. Ellis	26
Col. Bryan Evans	27
Lt. R. N. Faulkner	28
Lt. Col. Paul M. Fitts	29
Major S. K. Guth	30
Lt. C. G. Hamaker	31
Dr. A. C. Hardy	32
Dr. H. K. Hartline	33
Dr. Selig Hecht	34
Dr. Edwin R. Henry	35
Dr. E. O. Hulburt	36
Capt. J. H. Korb	37-41
Lt. Comdr. David Leavitt	42
Dr. Don Lewis	43
Lt. Harry London	44
Dr. Donald G. Marquis	45
Dr. Walter Miles	46
Lt. Philip Nolan	47
Dr. Brian O'Brien	48
Comdr. E. B. Oliver	49
Lt. Edgar O'Neil	50
Lt. (jg) F. O. Ottie	51
Lt. Comdr. R. H. Peckham	52
Major Ernest A. Pinson	53

Distribution List (continued)

Members and Consultants	Copy Nos.
Lt. Nathan H. Pulling	54
Lt. Walter Romejko	55
Col. D. B. Sanger	56
Capt. C. W. Shilling	57-59
Capt. R. M. Toucey	60-62
Dr. Richard Tousey	63
Col. Derrick T. Vail	64
Lt. (jg) W. S. Verplanck	65
Comdr. Lester Wolfe	66
Dr. Fred E. Wright	67
OSRD	
Office of the Executive Secretary	68
Liaison Office for transmittal to:	69-107
Liaison Office files (2)	
Australian Scientific Research Liaison Office, Washington (2)	
British Commonwealth Scientific Office, Washington (1)	
Canadian Joint Staff, Washington (1)	
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NDRC	
Office of the Chairman	
Mr. J. E. Jackson	108
Applied Psychology Panel	
Dr. W. S. Hunter, Chief	109-110
NRC	
Division of Medical Sciences	
Dr. T. R. Forbes	111

Distribution List (continued)

NRC	Copy Nos.
Committee on Selection and Training of Aircraft Pilots	
Dr. Morris S. Viteles	112
Army	
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Adjutant General's Office	
Lt. Col. M. W. Richardson	114
Armored Medical Research Laboratory Fort Knox, Kentucky	
Col. Willard Machle	115
Hqs. Air Technical Service Command Engineering Division Aero Medical Laboratory Wright Field, Dayton, Ohio	
Library	116
Field Artillery School Fort Sill, Oklahoma	
Library	117
Navy	
Amphibious Training Command U. S. Atlantic Fleet, NOB Norfolk, Virginia	
Lt. John Sulzman	118
Bureau of Medicine and Surgery Aviation Psychology Branch	
Comdr. John Jenkins	119
Lt. Harry Older	120
Bureau of Naval Personnel Standards and Curriculum Division	
Lt. J. C. Snidecor	121
Bureau of Ships Physics Research Section	
Lt. Comdr. R. M. Langer	122

Distribution List (continued)

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Medical Field Research Laboratory Camp Lejeune, North Carolina Comdr. W. N. New	123
Naval Air Material Center Navy Yard, Philadelphia, Penna. Lt. John A. Bromer	124
Naval Air Technical Training Center U. S. Naval Air Station Corpus Christi, Texas Capt. John R. Poppen	125-126
Naval Air Training Center U. S. Naval Air Station Pensacola, Florida Senior Medical Officer	127
Naval Medical Research Institute Bethesda, Maryland Capt. E. G. Hakansson	128
Lt. Comdr. R. H. Lee	129
Naval Training School (Recognition) U. S. Naval Training Center Gulfport, Mississippi Commanding Officer	130
Operations Research Group Dr. George E. Kimball	131
Dr. E. S. Lamar	132
U. S. Naval Air Station Quonset Pt., Rhode Island Lt. (jg) Jesse Orlansky	133

Dr. Dean R. Brimhall Director of Research Civil Aeronautics Administration Washington, D. C.	134
Dr. Howard S. Coleman Pennsylvania State College State College, Pennsylvania	135

Distribution List (continued)

	Copy Nos.
Dr. C. A. Douglas National Bureau of Standards Washington 25, D. C.	136
Dr. Irvine S. Gardner National Bureau of Standards Washington 25, D. C.	137
Dr. Matthew Luckiesh Lighting Research Laboratory Nela Park Cleveland, Ohio	138
Dr. George E. Wald Biological Laboratories Harvard University Cambridge, Mass.	139
Vision Committee files	140-175

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ARMY - NAVY - OSRD VISION COMMITTEE

MINUTES

Tenth Meeting
National Academy of Sciences
Washington, D.C.
1000, 13 March 1945

The following were present:

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			Ens. Brian O'Brien, Jr., Equipment and Materials, Camouflage
			Lt. Harry H. Stuart, Equipment and Materials Branch, Camouflage
	BuMed	(M)	Capt. J. H. Korb
		(A)	Lt. Comdr. R. H. Peckham
			Comdr. John Jenkins, Aviation Psychology Branch
			Lt. Harry Older, Aviation Psychology Branch
			Lt. D. D. Smith, Aviation Psychology Branch
	BuOrd	(M)	Comdr. S. S. Ballard
		(A)	Lt. Nathan H. Pulling
		(CM)	Lt. Philip Nolan
			Lt. George Dale
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			Lt. (jg) J. C. Snidecor, Standards and Curriculum Division
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			Lt. Comdr. R. M. Langer, Physics Research Section
			Lt. Lewis Rubinstein, Research and Standards Branch, Camouflage
	I C Bd	(M)	Lt. Comdr. George W. Dyson
			Comdr. W. T. Jenkins
			Comdr. R. C. Peden
			Mr. Allen E. Swim
	NMRI	(CM)	Dr. Harold F. Blum
			Lt. M. B. Fisher
			Lt. Comdr. R. H. Lee
	NO	(M)	Lt. (jg) F. O. Ottie
			Dr. Robert L. Mooney, Material Department
			Dr. T. Townsend Smith, Material Department
	NRL	(M)	Dr. E. O. Hulburt
		(A)	Dr. Richard Tousey

	SONRD	(M)Lt. Comdr. H. Gordon Dyke
	SubBase	(M)Capt. C. W. Shilling
		(A)Lt. (jg) W. S. Verplanck
	ATC	Lt. C. W. DeWitt
		Lt. J. H. Sulzman
		Ch. Pharm. J. R. Pence, Service Force, U. S. Atlantic Fleet
	MFRL	Comdr. W. N. New, Medical Field Research Laboratory, Camp Lejeune
		Lt. Comdr. J. F. Regan, Medical Field Research Laboratory, Camp Lejeune
	NAS	Lt. W. B. Clark, Dispensary, U. S. Naval Air Station, Pensacola
		Lt. (jg) Jesse Orlansky, Dispensary, U. S. Naval Air Station, Quonset Point, R. I.
	ORG	Dr. George E. Kimball, Operations Research Group
		Dr. Edward S. Lamar, Operations Research Group
		Dr. Henry Hemmendinger, Operations Research Group
	USMC	Lt. Col. Jack Cram, United States Marine Corps
OSRD	NDRC	(M)Dr. Theodore Dunham, Jr.
		(M)Dr. Arthur C. Hardy
		(M)Dr. Brian O'Brien
		(CM)Dr. F. E. Wright
		Dr. Lloyd H. Beck, Brown University, Contract OEMsr-1229
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		Miss Lillian R. Elveback, Technical Aide, Section 16.1
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		Dr. Harold F. Weaver, Consultant, Section 16.1
	APP	(M)Dr. Charles W. Bray
		(M)Dr. H. K. Hartline
	NRC	(M)Dr. Selig Hecht
	OSRD	(M)Dr. Donald G. Marquis

Dr. I. S. Gardner, National Bureau of Standards
Wing Comdr. Percy A. Lee, RAF Delegation
Lt. Cdr. J. A. Powell, Canadian Joint Staff
Surg. Lt. H. Z. Sable, Canadian Joint Staff

1. The chairman called for corrections or alterations in the Minutes and Proceedings of the ninth meeting. There were no corrections.

2. Lt. Comdr. Peckham has forwarded a supplementary statement to his report on ultraviolet absorption of plastics (Proceedings, sixth meeting, p. 22). 9*

3. Dr. O'Brien reported recent technical developments of the NDRC sun-obscuring device described at a previous meeting (Proceedings, eighth meeting, pp. 27-30).

4. Lt. Comdr. Peckham reported on the present status of goggles and sunglasses in the U. S. Navy. 10

5. Lt. Snidecor described proposed changes and developments in the Navy lookout-recognition training program.

6. Dr. Bray discussed data from several Applied Psychology Panel projects bearing on the problem of the utility of fixed-focus optical instruments. 13

7. Lt. Comdr. Peckham reviewed research establishing the need and requirements for sunglasses for military personnel, the status of procurement, and recent evidence concerning the effect of solar radiation on dark adaptation. 17

8. Comdr. Bittinger reported that Bureau of Ships has initiated an investigation to determine the optimum shape, size, and brightness contrast of numbers to be legible at required ranges and have minimum visibility beyond these ranges. A report of this study will be made to the Vision Committee at a future meeting.

9. Dr. Lamar discussed the preliminary results of a study of the visibility of asymmetrical targets. For cone vision, if the maximum dimension of the target is less than 3 minutes of arc subtended at the eye, visibility is a function of contrast and area and is independent of shape. If the maximum dimension is greater than 3 minutes, the effect of asymmetry sets in. A target should be designed so that most of the light will reach the center of the retina. A radially symmetrical target is the best target. Dr. Hecht stressed the implications for practical problems of search.

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*Numbers at the right refer to pages in the Proceedings on which the full report or discussion is presented.

**Confidential supplement.

ARMY - NAVY - OSRD VISION COMMITTEE

PROCEEDINGS

Tenth Meeting
National Academy of Sciences
Washington, D.C.
1000, 13 March 1945

2. SUPPLEMENTARY STATEMENT ON ULTRAVIOLET ABSORPTION OF PLASTICS

Lt. Comdr. R. H. Peckham

At the sixth meeting of the Vision Committee, the author had occasion to report that certain cellulose acetate plastics containing phenylsalicylate as a stabilizing agent transmit no ultraviolet in the erythemal region of the solar spectrum. Since that time additional information has been elicited concerning the material "Lucite". Ordinary Lucite as prepared by the Du Pont Company transmits a considerable amount of erythemal ultraviolet. However, Lucite sheeting No. JC-306, which contains a stabilizing agent, transmits no radiation lower than 340 millimicrons and is, therefore, useful for airplane windows when protection against erythemal radiation is essential.

The regular Lucite (HC-201) which transmits erythemal ultraviolet loses its ability to transmit ultraviolet upon exposure of a year to sunlight in Florida. It is suggested, therefore, that aircraft enclosures made of this material, which have been exposed continually to sunlight for considerable periods, may be impervious to erythemal ultraviolet although when new they transmitted a significant and potentially damaging amount. A laminated material prepared by the Du Pont Company which includes the material "Butacite" (Polyvinyl Butyral Resin) transmits very little erythemal ultraviolet. Laminations made of Lucite JC-306 and Butacite do not transmit erythemal ultraviolet. Laminations made of Lucite HC-201 and Butacite transmit less than 3% of erythemal ultraviolet.

4. THE PRESENT STATUS OF GOGGLES AND SUNGLASSES IN THE U. S. NAVY

The following report was prepared and presented by Lt. Comdr. R. H. Peckham.

Owing principally to the discussions and recommendations of this Committee, the U. S. Navy is procuring visual protective devices in large volume. Three types of protection are being undertaken: prevention of loss of dark adaptation, protection against glare, and protection against the solar image on the retina in sun scanning.

Protection against loss of dark adaptation is accomplished by the use of the special dark red goggle lens. This lens is made of plastic, and is inserted in the "All-Purpose" goggle, which is issued to officers and men who have night duties. About 2,000,000 pairs of the original design were purchased from the Polaroid Corporation. An improved design permitting greater field of vision and better ventilation has been developed, partly from the stimulus of this Committee, and nearly 1,000,000 of these are being procured.

This Committee, in October, voted to recommend that sunglasses be not over 15% transmission. As a direct result of this recommendation, an order was placed with the American Optical Company for 1,000,000 pairs of all plastic sunglasses, neutral in color, polarizing (axis vertical) from 10% to 15% tranmission. The Army followed this action with additional much larger orders, and the Navy, having received 500,000 of the first order, is now procuring nearly 1,000,000 more.

The same plastic material is being procured in the form of an attachable lens for the new "All-Purpose" goggle.

A modification of this All-Purpose frame is being used in the Bureau of Aeronautics as an alternate flying goggle. Thirty thousand pairs have been procured. This goggle is similar to but of larger field than the Army B-8 rubber and plastic goggle.

Two years ago, the Committee on Medical Research recommended the use of neutral lenses in goggles and sunglasses as less prejudicial to color vision than tinted lenses. The green and amber glass lenses in the aviation flying goggle are being replaced by neutral glass lenses of 20% transmission. Although this is slightly higher than the recommendation of this Committee, it was felt that the light at dawn and dusk would not permit a darker lens. The same density lens is being developed for the aviation type sunglass, but owing to the difficulty of procuring large numbers of glass lenses, this replacement is at present being developed in plastic. Approximately 350,000 pairs of

neutral glass lenses and 350,000 pairs of neutral plastic lenses will be needed by the Navy for this conversion from Calibar, Rayban, and Rose-Smoke lenses to neutral gray lenses.

Estimates of the amount and effect of solar radiations have been made directly at the behest of this Committee. As the result of these reports, the Navy has set no specifications against ultraviolet and infrared in sunglasses, but has set certain maximum transmissions for sun-scanning devices. These transmissions, in brief, are less than 10% for erythemal ultraviolet, less than 1% for visual light, and less than 20% for total solar energy, including the infrared portion of sunlight.

Sun-scanning devices have been developed according to these specifications. Dr. Walter Miles, through this Committee, presented a sun-scanning device, five hundred of which are being procured from the Polaroid Corporation. The Variable-Density Goggle was examined with regard to these specifications and was found to need additional absorption. A method of providing this has been reported to the Committee, and new procurements will contain the additional protection recommended.

A variable-density device being procured for use as an attachment to binoculars, to permit sun scanning, has been examined and found satisfactory.

This Committee has therefore been very influential in the provision of visual protective devices.

<u>Discussion</u>:

Lt. Comdr. Dyson reported that sunglasses fulfilling the requirements recommended by the Vision Committee (<u>Minutes</u>, sixth meeting, p.7, item 6) have been incorporated in the special clothing allowances for Naval personnel. A memorandum from the Office of the Chief of Naval Operations, Serial 22950-A, 21 December 1944, on standardization and allowances of special clothing for Naval personnel includes the following:

(A) Allowances for male personnel serving AFLOAT:

1 pr. Goggles, N-1 - item in Standard Sea Outfit
(Glasses, Sun N-1 may be substituted in lieu of Goggles, N-1)

(B) Allowances for male personnel serving ASHORE at Overseas Bases:

(1) Individual allowances established according to the climatic zone in which the base is located:

1 pr. Glasses, Sun N-1 - item in Standard Overseas Base Outfits for tropic zone
1 pr. Goggles, N-1 - item in Standard Overseas Base Outfits for arctic zone
(Glasses, Sun N-1 may be requisitioned in lieu of Goggles, N-1)

(2) Operational allowances for each unit in addition to individual standard outfits established according to the climatic zone in which the unit is located: (Percentages show the allowance according to personnel attached.)

10% - allowance of Glasses, Sun N-1 for Seabees in temperate zone.
10% - allowance of Glasses, Sun N-1 for all other Advanced Base personnel in temperate zone

(C) Allowances for male personnel serving ASHORE within the continental limits of the United States:

10% - allowance of Glasses, Sun N-1 for Air Bases, Air Stations, and Anti-Aircraft Training Centers.

6. NOTE RE FIXED-FOCUS OPTICAL DEVICES

The following report was prepared and presented by Dr. C. W. Bray.

The possible value of the fixed-focus as compared with the common, variable-focus optical device has been discussed at various times in the Army-Navy-OSRD Vision Committee. Several projects of the Applied Psychology Panel have collected, as a by-product of other research, data which bear upon the problem. The data show that under different conditions of use of variable-focus devices Service personnel obtain markedly different values of best focus. It is suggested that the differences may depend in large part on the procedures used. If the possible economic gains from fixed-focus are great or if operating simplicity in combat areas is significant, then the data suggest the desirability of a direct, large-scale study of the problem.

Our results are given in the table below which shows the means and sigmas of the distribution of the best focus setting of stereo devices in three series of investigations from our Project on Height Finder Operators, Project N-114, and Project SOS-6. All values in the table are for the left eye. Similar records for the right eye are not reported here since they show the same type of result. The table also shows the more significant, known conditions which might affect results, including nature and number of subjects, device and target used, whether monocularly or binocularly viewed, and psychophysical procedure.

Examination of the table shows two groups of obtained mean values for the setting: (1) values varying around zero D and (2) values varying around -1.25D. This difference in mean values occurs even when the same men, device and field of view are used, as shown by the two sets of results from the Project on Height Finder Operators.

The difference between monocular and binocular viewing is commonly known to produce a more negative setting by the monocular method. However, the difference is usually expected to be much smaller than 1D. In the results from Project N-114, as shown in the table, the only difference in conditions is that of monocular versus binocular view. The obtained difference in results is a more negative mean setting of 0.16D for the monocular method. This does not, therefore, account for our two main types of result.

The only remaining, known, possible source of the two groups of mean values is the psychophysical procedure. Two procedures

Project	Subjects	Device and Target Used	Procedure	Psychophysical Method	No. of Subjects	Mean Setting	Sigma
Height Finder Operators	Army School for Stereo Height Finder Operators Preselected on visual standards.	Field of Army M2 Stereo Height Finder	Binocular	¼D steps from high plus setting	28	0.0	.61
Height Finder Operators	Army School for Stereo Height Finder Operators. Preselected on visual standards.	Field of Army M2 Stereo Height Finder	Monocular	Gradual change from high plus setting	28	-1.55	1.24
Project N-114	Navy School for Stereo Range-finder Operators. Preselected on visual standards.	Reticle of Mk2 Stereo Trainer	Binocular	½D steps from + 2.0D (9 trials per subject)	368	+0.14	0.52
Project N-114	Navy School for Stereo Range-finder Operators Preselected on visual standards.	Reticle of Mk2 Stereo Trainer	Monocular	¼D steps from + 2.0D (9 trials per subject)	491	-0.02	0.75
Project SOS-6	NROTC Students	Reticle of Mk2 Stereo Trainer	Monocular	Gradual change from high plus setting (3 trials per subject)	72	-1.3	0.85
Project SOS-6	NROTC Students	Reticle of Mk2 Stereo Trainer	Monocular	Gradual change from high plus setting (5 trials per subject)	19	-1.5	1.00
Project SOS-6	Navy School for Stereo Range-finder Operators	Reticle of Mk2 Stereo Trainer	Monocular	Gradual change from high plus setting (10 trials per subject)	82	-1.1	0.96

were used. (1) Observation began with a high positive setting. If the field seemed unclear the setting was made 0.25D less positive and the judgment repeated. The procedure was continued until the subject pronounced the field clearly focussed. (2) Observation also began at a high positive setting, but the setting was continuously and gradually changed in the less positive direction until the subject pronounced the field clear.

The difference in procedure does not seem great. Nevertheless, the three mean values around zero D were obtained by the first procedure, and the four mean values around -1.25D were obtained by the second procedure.

Even though this explanation of the difference should prove unsound, it is clear that Service personnel may be expected to set in quite different values of focus under different circumstances. Carelessness, under field conditions, will add to the variability.

There is no evidence from any of our projects that erroneous settings produce more than the usual number of complaints of eye-strain or affect efficiency (except that a markedly different setting for the two eyes causes a twisting of the frontal plane about the vertical axis which may affect the accuracy of stereo judgments). On the contrary there are informal reports that erroneous settings of 1.0 to 1.50 do occur without complaint or apparent loss of efficiency. Informal reports of this character are not a proper basis for action at the production level. They do definitely point to the need for research in the interests of economy and of simplicity of operation in combat areas.

Discussion:

Dr. Wright felt that of the two procedures, the gradual procedure might give more accurate focus than the step-by-step procedure. The habitual manner of setting microscopes involves a gradual passing back and forth in the area of best focus; this method has perhaps become the "natural" one. Dr. Bray explained that the 1/4 step procedure was preferred at the Fire Control School because it gives a more positive setting.

Comdr. Ballard emphasized the importance of further study of the problem of fixed focus. The Bureau of Ordnance is attracted by fixed focus because it has the advantage of affording a tight assembly.

Dr. O'Brien commented that many practical telescopes have a good deal of field curvature. He asked for comment on the practice of setting the edge of the field at infinity and allowing the center

of the field to fall where it may. Lt. Nolan thought that adjusting the edge of the field to zero for sights that have a curvature of -4D would be impractical, but it might be done for those having a curvature of -2D.

Dr. Hardy pointed out that visual acuity for the same target angle decreases at close distances. An observer focusses for sharp image and cuts down his acuity; the image looks sharp because of the decrease in acuity.

Dr. Tousey said the pupil contracts if an observer accommodates for a negative setting at night. If the setting is too far minus, the pupil will contract and less light will reach the retina. Dr. Wagman, citing a British report which investigated accommodation at low levels of illumination, explained that pupil contraction is insignificant for an accommodation of 1D, and perhaps even 2D. At -4D it might be significant.

Dr. Bray asked if any work had been done on the importance of border contrast on night acuity.

Dr. Hecht stated that the Subcommittee on Visual Problems of the Committee on Aviation Medicine has decided to investigate all of the visual aspects of the problem of binocular design and use.

7. NEED AND REQUIREMENTS FOR SUNGLASSES AND EFFECT OF PROLONGED EXPOSURE TO SUNLIGHT

The following report was prepared and presented by Lt. Comdr. R. H. Peckham.

At various times descriptive articles on sunglasses have appeared in the Minutes and Proceedings of the Vision Committee. Both the Army and Navy are procuring sunglasses which were developed principally on the basis of discussions of this Committee. These reports have been in fair agreement as to both the need for and the design of sunglasses. Various service tests have been made, the reports of which have been presented to this Committee in some instances. It is the purpose of this paper to review these reports, to establish the need for sunglasses, and to summate the research and procurement aspects of this problem.

It has been decided that sunglasses should be between 10% and 15% transmission, neutral in color, polarizing with the axis vertical, made of plastic, suspended in a comfortable, light, and adjustable frame, and should provide as large a field of view as possible. The glasses should be delivered in a case permitting easy attachment to the belt and quick access to the sunglasses. They should be provided to all personnel who anticipate night duty.

The choice of these criteria have been made as a result of both experimental study and field experience. Dr. Selig Hecht determined the effectiveness of sunlight in destroying dark adaptation at Camp Lejeune about six months ago. His experiments showed that exposure to sunlight on the beach resulted in accumulated loss of dark adaptation, and that this loss continued for a long period of time even after the men were returned to the shaded conditions of classrooms.

Dr. Hecht, as a result of these experiments, recommended a sunglass of transmission between 1% and 5%. Experiments at Patuxent, Md., by the Navy, indicated that when sunglasses of 10%, 4%, and 1% were provided, personnel preferred the 4% in the majority, the 10% in the minority, and nearly unanimously rejected the 1% lenses. It therefore became necessary to provide additional protection beyond the transmission characteristic of the lens to be used. For this reason a polarizing lens was introduced which has the advantage of absorbing a large portion of reflected glare from horizontal surfaces. In this manner the total energy striking the retina was reduced materially below the non-polarizing or scattered transmission of the lens. Hence, it was felt that a 10% to 15% lens, polarizing, would result in sufficient protection. Discussion of the effect of tint

on color vision resulted in the decision to use neutral lenses.

Experimental studies of the effectiveness of this sunglass have not been made since two factors, the permissible density and the degree of glare present over water, have served to convince the Navy that for better or for worse this sunglass will have to be used. It is to be hoped that following the extensive use of the sunglass evidence will be forthcoming as to its effectiveness. A study is being undertaken comparing the effect of neutral and tinted glasses on color vision. This study is not yet complete and will not be complete for some time. The apparent need for sunglasses has resulted in the specification of neutral lenses in anticipation of the results of this study. This neutral specification has been set at 2 Munsell units but the manufacturers of the lens have been able to produce a lens whose average color is less than 1 Munsell unit. The production of these sunglasses has been fraught with difficulties which were not anticipated in the manufacture of tools. The production schedule is now five months behind. This delay has been annoying and, unless prompt action to distribute the glasses thus far prepared is undertaken, it may prove of considerable disbenefit to the Armed forces.

The production of sunglasses has been considered sufficiently important to have assigned double-A priority to the assembly of the glasses and triple-A priority to the preparation of tools. We are fortunately able to announce today that the tool problem has been overcome, that the Navy procurement is now being carried out at the rate of nearly 150,000 pairs per week, and that the Army procurement can be expected to double this in a very short time. The Navy is, therefore, planning to release sunglasses immediately to all personnel afloat who anticipate night duty. The Bureau of Aeronautics is providing its personnel, especially those on carrier duty, with these sunglasses and is in addition undertaking to substitute a neutral glass or plastic lens in the aviators' sunglass. This aviators' sunglass, incidentally, will be non-polarizing and of 20% to 30% transmission and will therefore not be as effective as the standard sunglass. It will be considerably more useful than the previously accepted greenish or yellowish tinted lenses such as Calibar, Rayban, and Rose Smoke.

A great deal of evidence has been uncovered during the past two months concerning the effect of solar radiation on dark adaptation and supporting Hecht's experimental results to a degree so great that additional experiments may be unnecessary. These effects will be discussed below categorically:

1. <u>Geographic Shift of Dark Adaptation</u>. The Radium Plaque Adaptometer is being used throughout the Navy to screen out severely night blind personnel. The results of this screening are expressed in terms of the proportion of the population who

can see a given number of exposures at a certain level of brightness. Varying exposure to solar radiation due to differences of latitude is directly reflected upon this aggregate dark adaptation score. An estimate of the differences would indicate that they represent about 0.3 log units difference between the latitude extremes.

2. Seasonal Shift of Dark Adaptation. Similar comparison of aggregate scores for shore establishments from month to month shows a seasonal variation. This variation reaches a maximum of failures in August and a minimum in January. The amount of change represents about 0.15 log units of loss in the summer. This is a relatively small amount, but is much more noticeable in the New York area than in the Florida area. It is suspected that these changes with geographical and seasonal shifts are probably associated with changes in sport and living habits as much as actual changes of sunlight intensity.

3. The Shift of Scotopic Flash Limen with Respect to Latitude. Reports of scotopic flash limens in the neighborhood of New York City indicate that the value 2.3 log micro micro lamberts is an expectable average at the 60% frequency of seeing a flash of violet light exposed for one-fifth of a second in the Hecht-Schlaer Adaptometer. Measurements of the Royal Canadian Navy, which also uses this adaptometer as a testing instrument, indicate approximately 2.1 to 2.0 log units as an expectable limenal value. Measurements at Pensacola indicate 2.9 log units at the 60% level of seeing. These are direct measurements of scotopic flash limens, and confirm the reflection of latitude upon the limit of dark adaptation, indicating a difference of 0.6 log units or nearly one-fourth the retinal sensitivity.

4. Shift of Dark Adaptation Due to Sea Duty. Far greater than the geographic shift, the effect of sea duty can be shown to change seriously the proportion of the population measured on the Radium Plaque Adaptometer. The amount of this shift is quite large and at present the best estimate is that it amounts to at least 0.5 log units. This is an amount in excess of that reported by Hecht for one week's duty on the beach and is the result of accumulated long daily exposure to the sun and to the glare of the sun on water.

5. The Effect of Exposure Upon the Duration of Twilight. It has long been noticed and reported that the twilight seems shorter in the tropics. The shift of this apparent illumination in twilight is measured in minutes of photopic visibility after sunset. A recent CAM report by Dr. Hecht includes the measurement of twilight illuminations. If it is assumed that the effect of exposure to sunlight is to shift the retinal sensitivity, comparison of this shift with the curves of twilight intensity explains a large part of the shortening of twilight in tropical areas.

6. <u>The Effect of Sunlight Exposure on Ship's Lighting.</u> An examination of the directives issued by the Bureau of Ships for the lighting of ship's compartments has produced an unexpected and interesting support of the doctrine of loss of visual sensitivity resulting from exposure to sunlight. The illumination in ships is kept at a minimum level in order to reduce the drain on ship's electrical systems and to avoid over-illumination within the ship. For example, the maximum levels of illumination three feet from the floor for chart rooms and libraries has been set at ten apparent foot candles. Directives prohibit the change of size of bulbs within these fixtures but require frequent and careful polishing of reflectors and frequent changing of bulbs when they are slightly worn. The need of this directive indicates the habit of ship masters to increase the illumination over these levels after they are at sea. The effect of retinal desensitization is found, of course, at all levels of illumination, and amounts to at least 0.3 log units, or one-half. This would mean that the directed ten apparent foot-candle level would be reduced by virtue of retinal desensitization to a brightness of five foot candles. This is a brightness below that required for comfort and convenience and might produce eye strain even though the wattage and illumination levels are unchanged. Consequently, it follows that complaints of lack of illumination would stimulate changing of the physical brightness to match the retinal sensitivity.

7. <u>Specific Instances of Physiological Damage to the Eye.</u> Instances of damage are seldom reported, and are rather rare. An individual whose retinal sensitivity has been reduced interprets this reduction as a decrease in brightness and not as a decrease in his own ability to see at night. However, careful questioning of individuals exposed to sunlight usually leads to the conclusion that such personnel cannot see as well at night as personnel not exposed to sunlight. Actual damage due to continual exposure to sunlight has been reported twice to this author by personnel engaged in flying model airplanes used as targets in anti-aircraft practice. In one case, the subject claimed that his visual acuity was greatly improved as a result of sunlight, but his pupil was found to be reduced to less than one millimeter out-of-doors and to dilate to less than 2 millimeters indoors. Consequently, exposure to sunlight had resulted in the production of a pinhole which, of course, sharpened his vision considerably. This individual had entirely given up going to the movies or going out-of-doors at night. In another instance, a person performing similar duty in the Miami area has developed bilateral pterygium. The normally tiny vestigial third eye lid had hypertrophed to a degree that required operation.

8. <u>Inferred Evidence of Poor Japanese Dark Adaptation.</u> In addition to the direct evidence available from the examination of

U. S. Navy records, we can infer a degree of loss of dark adaptation in Japanese personnel on duty on small coral islands. The first indication of this condition came as an inquiry from the British as to the actual physiological limen of the Japanese retina. It was suggested that the Japanese were partly night blind. No direct evidence could be obtained to support this suggestion and it seemed at the time improbable that a racial difference existed. However, the recent capture of islands included the capture of large amounts of vitamin A concentrate, which was being fed to Japanese personnel in massive doses. Furthermore, intercepted Japanese broadcasts directed as propaganda against United States troops described the difficulty of fighting an enemy at night who could not be seen, boasted of an ability of the Japanese warrior to render himself invisible, and claimed that an ophthalmic operation which included the injection of plant extracts into the retina had resulted in production of Japanese personnel able to see perfectly in nearly total darkness. It is the opinion of the Research Division at the Bureau of Medicine and Surgery that this is an idle boast directed to frighten American troops from attacking at night, and possible evidence of the vulnerability of the Japanese to night attack. Conversations with Marine pilots have elicited the information that Japanese night fighter tactics are usually confined to moonlit nights. The observation that the use of photo-flash bombs results in a cessation or complete inaccuracy of Japanese anti-aircraft fire has been reported in newspapers. All of these observations lead to the conclusion that some of the Japanese are to a degree night blind. This would be most probably true for those men stationed for long periods on small coral islands. Their days are spent in watching the ocean and being subjected to the glare of the sunlight, in the morning to search for the expected American attack, and in the evening to look towards their homeland.

In conclusion, therefore, it seems fairly well established that the effect of exposure to sunlight without the protection of dark sunglasses results in a loss of retinal sensitivity of a degree sufficiently great to affect materially the efficiency of military personnel. Measurements of tolerable densities of sunglasses have resulted in the specification of a particular type which is being procured in large amounts. In order to improve the efficiency of battle troops, every effort must be made to enforce the wearing of sunglasses by all personnel.

<u>Discussion</u>:

Ens. O'Brien, Jr. asked what period of time produced maximum damage as a result of exposure to sunlight and whether or not this damage is temporary. Dr. Hecht explained that the amount of damage

cannot be expressed in time; rather it is a function of time, intensity, and area. Lt. Comdr. Peckham said that after periods from a few days to several weeks ashore, the effects are still apparent.

Dr. Blum asked if any attempt had been made to calculate the effect of latitude on intensity of light. He recommended that these calculations, as well as estimates for the variation of ultraviolet with latitude, be made even though other factors such as reflection of sun on water and living habits contribute to the seasonal and geographical shifts in dark adaptation threshold.

Dr. O'Brien thought it unlikely that ultraviolet rays short enough to show marked seasonal fluctuation can reach the retina, but he agreed that such measurements should be included in further experiments. Dr. Blum pointed out that he was not considering the direct effect on the retina, but the indirect effect on the cornea.

An experiment has been designed to determine the effect of ultraviolet light on dark adaptation, but Lt. Comdr. Lee reported that it is just in the initial stages.

Lt. Orlansky stated that seasonal variations in dark adaptation corresponding to those reported by Lt. Comdr. Peckham have been observed at Quonset Point. A slight decrease in scores in February may be related to the greater reflection from snow. Surg. Lt. Sable offered to secure Canadian data relating to this point.

Several members were concerned that the Services were satisfied without further research on this problem. Dr. Hecht pointed out that future research would be a CMR project, but Navy cooperation in providing personnel and facilities is essential.

10. DESIGN AND DEVELOPMENT OF 7X50 STANDARD NAVY BINOCULARS

The following report was prepared and presented by Lt. Charles G. Hamaker.

One of the most important requirements of the U. S. Navy during this war was the waterproofing of optical instruments. In order to meet this requirement, the following alterations in design have been made:

1. Elimination of all wax seals. Due to the impracticability of using wax as a seal, all standard binoculars have been redesigned in order to use gaskets made from hycar, koroseal, neoprene, and buna formulations. These gaskets are made with uniform thickness and provide an excellent seal which is far superior to wax. Gaskets are now being used for the eye lens, cover plate screws, objective to body, cover plate, and eyepiece.

2. New design of eyepiece. In the earlier design of Navy binoculars an attempt was made to keep the binoculars dry by depending on close tolerances of the eyepiece threads and the use of heavy grease. Inasmuch as water had a tendency to enter the grease, each time the diopter setting was changed, the water would be forced into the binocular by the pumping action of the eyepiece. In order to correct this defect, a sealing device which acted as a wiper was incorporated and was constructed so as to insert a round hycar gasket. This device will enable the binocular to withstand 20 lbs. pressure and can be adapted to any type of binocular.

3. Redesign of cover plates. Cover plates have also been redesigned in order that a gasket may be used as a seal between the cover plate and the body. In the present design of cover plates the eyepiece sleeve has been incorporated as an integral part of the plate. This eliminates any water entering the binocular around the threads of the sleeve and the cover, a defect quite prevalent in the older designs.

4. New processing of bodies. In the processing of bodies considerable porosity has been present which results in breathing and ultimate fogging up of the instrument. A means of eliminating this defect has been the adoption of a drawn tube. Bodies made by this process result in elimination of porosity, thinner wall thickness, and a stronger body. Attempts have been made to manufacture bodies from magnesium; however, no suitable bodies have as yet been formulated.

5. Pressure testing. Binoculars were at one time tested for watertightness by dunking them into a tub of water. This practice was not sufficient proof of the watertightness of the instrument; however, it was the only test by which binoculars could pass waterproof inspection. As new means of making the binoculars absolutely watertight were developed, a new testing technique was adopted which consists of inserting a nipple into the cover plate and subjecting the binocular to 15 lbs. pressure when totally immersed in water. No bubbles should appear on or from the binocular within two minutes.

6. Selica gel desiccator. A plastic indicating desiccator has been developed and is being inserted between the eye prism cover and the cover plate of all binoculars. In the event that a small amount of moisture enters the binocular the selica gel desiccator will absorb the moisture. It is believed that, by the use of the desiccators, a binocular can remain in service for longer periods of time before being overhauled. The prism shields have been made of heavier material and are slightly bowed so that there is no contact of the prism shield and the prism due to the introduction of the selica gel desiccator.

One of the most unsatisfactory parts in the design of binoculars has been the hinge construction. Although the early design of hinge proved satisfactory during peace-time conditions, the design would not withstand war-time hard use. To overcome this problem in instruments of older design, a new formulation of hinge grease is now being used which has aided sufficiently in keeping the binocular hinges from freezing. Newly designed hinge pins have been serrated to prevent the pins from turning inside the hinge lug, and Alemite fittings have also been incorporated in the hinge pin which will enable the hinge to be greased without sending it to a repair vessel and having the instrument disassembled. Plastic interpupillary scales with a small finger which will fit into a recess of the hinge have also been developed. This eliminates the necessity of tapping the hinge pin and inserting a screw, and also prevents the interpupillary scale from rotating when changing interpupillary distance.

The upper surface of the diopter setting ring has been serrated to prevent the diopter ring from slipping on the eye lens cell and to eliminate a set screw. Eyepiece tubes have also been serrated to accept the new diopter ring.

One of the greatest improvements in binocular design has been in the redesign of prism collars and plates. In the past, excessive prism chippage has taken place each time the binocular was subjected to a slight bump. In order to eliminate chippage, recessed

prism plates have been designed which prevent the prism from shifting. Eccentric shoes have also been incorporated to prevent strain in the mounting of prisms. The contact point of the prism collars has been raised so that contact is not at the base of the prism. This design has eliminated prism chippage to a great extent. It may be of interest to note that the Army has developed a technique of cementing prisms to the prism plates. However, the Navy has not as yet adopted this technique.

Eyepiece caps have been designed so that a recess which is for the purpose of attaching the variable-density filter is now on the top surface of the cap. A 15° angle has also been cut on the eye cap serrations to eliminate external reflections.

Objective guards manufactured of neoprene which can be adapted to the objective end of all binoculars have been designed. These guards will absorb shocks and have eliminated the breaking of optical elements resulting from rough handling while in service.

When changing the design of the binocular, every attempt has been made to make such changes that could be incorporated in instruments now in service by repair activities. Also the designs of binoculars are such that, on all new designs, parts are interchangeable with the comparable designs of various manufacturers.

(NOTE: The concluding paragraph of this paper appears on page 45 of the confidential supplement.)

APPENDIX

BIBLIOGRAPHY OF VISUAL LITERATURE 1939-1944

TABLE OF CONTENTS

*No classified reports filed under this heading.

3. VISUAL EXAMINATION AND TESTING (INCLUDING METHODS AND INSTRUMENTS)
    *I. Testing methods
    *II. Induction and employment standards
    III. Examination of inductees and military personnel
    *IV. Refractive errors
    V. Acuity
    VI. Color vision
    VII. Depth perception
    VIII. Night vision testing
    *IX. Accommodation
    X. Muscle balance
    XI. Interpupillary distance
    XII. Selection for military specialties
        A. Stereoscopic height finders and rangefinders
        B. Aircrew
        C. Radar operators
    *XIII. Malingering and neuroses
    *XIV. Special instruments
    XV. Aniseikonia

4. CORRECTION OF OCULAR DEFECTS IN MILITARY PERSONNEL
    I. General ophthalmology
    II. Dioptric correction
        A. Glasses
        B. Goggles
        C. Contact lenses
    III. Corrective training
        A. General
        B. Acuity
        *C. Phorias
        D. Color vision

5. TRAINING FOR MILITARY SPECIALTIES (INCLUDING OPTIMAL CONDITIONS AND PROCEDURES, JOB ANALYSES)
    I. Recognition
    II. Visual search
        A. Night lookout
        B. Air-sea search
        C. Naval lookout
        D. Ground patrol (including night firing)
        E. Night flying
    III. Specialized duties
        A. Rangefinding
        B. Radar (and C.I.C.) operation
        C. Other fire control
        D. Pilot

6. OCULAR TRAUMA (IN MILITARY SERVICES)
   - I. Mechanical injuries (incidence and types)
   - II. Chemical (gases, drugs)
   - *III. Burns (flash, general)
   - IV. Arc welding
   - V. Solar radiation
   - VI. Radar operation
   - *VII. Detached retina
   - *VIII. High and low pressure, blast
   - *IX. Localization and diagnosis
   - X. Surgical treatment
     - A. General
     - *B. Removal of foreign bodies
     - *C. Plastic surgery
     - *D. Keratoplasty
     - E. Prosthesis
     - *F. Enucleation
     - *G. Detached retina
   - *XI. Conjunctivitis
   - XII. Infections
   - XIII. Medical treatment
     - *A. General measures (drugs, physiotherapy, etc.)
     - *B. Sulfa drugs
     - C. Penicillin
   - *XIV. Trachoma
   - XV. Rehabilitation
   - XVI. Blindness

7. GOGGLES AND OCULAR PROTECTION
   - I. General purpose (sun, wind, dust)
   - II. Dark adaptation
   - III. Structural design
     - A. Fogging and frosting
     - B. Visual field restriction
   - IV. Helmets, face masks, visors
   - *V. Industrial protection
   - *VI. Gas protection
   - VII. Sun-scanning
   - VIII. Filter combinations simulating night vision
   - IX. Special visual aids
     - A. Tracer
     - B. Submarine targets
     - C. Horizon
     - D. Camouflage
     - E. Anti-searchlight

8. ILLUMINATION

I. Sources and materials
*A. General
B. Luminescent
II. Interior illumination
A. General
B. Cockpit
C. Ship
D. Submarine
E. Armored vehicles
F. Radar and other installations
G. Maps and charts
*III. Instruments and dials (see 8-II-B, cockpit and 10-I-C, reticles)
IV. Dazzle
*V. Factories
*VI. Airports

9. VISIBILITY AND SPECIAL PROBLEMS

I. Photometric data
A. Visibility of targets under natural illumination
B. Instruments and procedures
C. Sky brightness
D. Scatter, haze
II. Legibility
A. Dials and controls
B. Radar presentations
C. Printed markers
III. Blackout (including exhaust)
IV. Obscuration by smoke
V. Camouflage
A. General (materials, paints)
B. Ground
C. Ships
D. Aircraft
VI. Visual signals
A. Light
B. General
C. Ultraviolet and infrared
D. Retroreflective
VII. Transparent sections
VIII. Vision from enclosures
A. Tanks
B. Aircraft
C. Director control towers
IX. Gun flash
X. Searchlights
XI. Gunfire spotting

10. MILITARY USE AND DESIGN OF OPTICAL INSTRUMENTS AND AIDS TO VISION

- I. Fire control instruments
  - A. Gun sights (directors, trackers)
  - B. Night gun sights
  - C. Reticles
- II. Rangefinders
- III. Viewing devices (binoculars, telescopes, periscopes)
- IV. Special scanning devices
- V. Optical engineering; materials, methods

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10 pt. 2

SUPPLEMENT [or pt 2]
to

M I N U T E S   A N D   P R O C E E D I N G S

of the tenth meeting of the

ARMY - NAVY - OSRD VISION COMMITTEE

13 March 1945

National Academy of Sciences
Washington, D. C.

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U.S. Armed Forces - NRC Vision Committee

12. THE NDRC BINOCULAR TESTING PROGRAM

A. General Outline of the Binocular Testing Program

Dr. Theodore Dunham, Jr.

Under Project NO-210, Section 16.1 of NDRC has carried out an investigation of the relative effects of magnification and exit pupil on binocular performance at low levels of illumination.

An increase in magnification, while maintaining exit pupil unchanged, involves a proportional increase in the diameter of the objectives and focal length of the instrument. An increase in exit pupil, without change in magnification, involves an increase in diameter of the objective. Both of these changes increase the bulk, weight, and cost of binoculars, and so should not be undertaken without good evidence that significant gains will result.

There is no design for "the best binocular", to be used under all conditions. Higher magnification can probably be used at night than by day. However, in the presence of severe vibration, wind, or haze, the advantages of high magnification are markedly reduced. A large exit pupil diameter is important only at night.

At low levels of illumination, magnification increases the range at which a target can be seen, by a factor which would equal the magnification if (1) absorption could be eliminated, (2) the exit pupil diameter were held at least equal to the diameter of the pupil of the eye, (3) there were no linear vibration to disturb alignment between instrument and eye, (4) there were no angular vibration to cause motion of the image on the retina, and (5) the atmosphere were absolutely transparent, so that distant targets would not be at any relative disadvantage as compared with nearby targets.

When magnification is increased, exit pupil is necessarily decreased, if the diameter of the objective is maintained constant. A compromise must therefore be struck to get the greatest possible range on targets at low levels.

The trade between magnification and exit pupil is not even. The apparent background brightness varies as the square of the exit pupil diameter. But, at night sky levels, the apparent background brightness must be increased <u>tenfold</u> in order to <u>double</u> the range at which a dark target can be seen. Conversely, the brightness may be cut to one tenth before the range falls to one half. This means that it is worth while to cut the exit pupil

well below 7 mm. in order to gain magnification, while maintaining the diameter of the objective constant.

For example, consider the effect of converting the 7x50 binocular to 14x50, by merely changing eyepieces. If the light could be preserved constant, the range would be doubled. Actually, the light is cut to 1/4, which, in itself, reduces the range to about 65%. The net effect to be expected from ideal binoculars is therefore a gain of 30% (2x65-100) in range, when the 7x50 binocular is changed to 14x50. If no other factors were involved, it would be advantageous to increase magnification, at least to 100x50, where the exit pupil would be 0.5 mm. Beyond this point, resolution might be lost at moderate levels of illumination, with some loss in ability to detect targets. However, other factors enter long before this point is reached. These are (1) unsteadiness in holding, (2) reduction in eye relief, and (3) reduced field of view. In practice, these factors reduce the range attained with 14x50 binoculars below that attained with 7x50 binoculars.

Although the range at which a black target can be seen may be estimated, for ideal conditions, from its angular size and the flux per unit area on the retina, an empirical program is necessary to assess the usefulness to a human observer of binoculars which differ in bulk, weight, moment of inertia, and design of eyecups.

At Dartmouth College, a magnification series, ranging from 6X to 10X, was studied, while maintaining the exit pupil constant at 5 mm.

At Brown University, an exit pupil series, ranging from 2 mm. to 10 mm., with constant 5X magnification, has been studied. A series of glasses, with magnification ranging from 5X to 14X, has recently been tested to determine the most effective magnification for use with 50 mm. objectives, when the observers stand and hold the binoculars. The tests will be repeated with the observers seated and the binoculars supported on alidades. A 70 mm. series (ranging from 7X to 20X) will be studied in the same way. Some experiments will be made with the observers on a rolling platform.

At the University of Pennsylvania, studies are being made of the individual factors which affect binocular performance, particularly unsteadiness of holding. An examination of the results obtained at Dartmouth and at Brown has been made, to show how far they can be explained on the basis of apparent image size and flux at the retina.

While laboratory studies give excellent indications regarding the relative merits of various binoculars, it seems clear that they cannot entirely take the place of practical outdoor tests, preferably on shipboard, and carried out with various degrees of roll, wind, temperature, and haze. When laboratory screening tests have indicated that one binocular is better than another, for detecting targets at low levels, it should be easy to verify or disprove this indication, by direct comparison at sea. Unless there is general agreement regarding the results of such a comparison, it would scarcely be justifiable to recommend a change in production. But if the difference is clear cut, under varying night lookout conditions, then the change can easily be justified.

At present there is good indication that the range of detection at night sky levels is distinctly greater with hand-held 10x50 wide-field binoculars than with hand-held standard 7x50 binoculars. 9x63 binoculars give very slightly greater ranges than 10x50 binoculars.

B. Experimental Procedure and Correction Function Used in Studies Conducted at the Dartmouth Eye Institute

Dr. H. F. Weaver

The gain in range with binocular magnification for a fixed 5 mm. exit pupil was investigated at Dartmouth, at illumination levels of 40, 400, 4000, and 40,000 millimicrolamberts. Three observers who stood holding the binoculars by hand at 70 feet from the observing screen were used. Each determination of range was made on the basis of 48 six second exposures of a given target size under the chosen conditions of illumination and magnification.

Corrections for guessing to the apparent probability of detection scores were determined empirically for each of the three observers, and were considered to be dependent only on the difficulty of detection. The targets appeared in four possible positions, at 12, 3, 6, and 9 o'clock. Analysis of the incorrect responses showed that the observers named incorrectly the target position directly opposite to the true position less frequently than they did the two positions adjacent to the target. This seems to indicate that for targets below, but near threshold, the observers were able to detect the target, and name the semi-circle in which it appeared, but not to give its location. The smaller number of responses corresponding to the position opposite the target were taken as the best estimate of the extent of pure guesswork. The corrections so determined were less than those given

by the customarily used algebraic formula. Analysis of the incorrect responses is given in detail in the final report under Contract OEMsr-1058, OSRD Report No. 4433.

C. Results of Studies Conducted at the Dartmouth Eye Institute

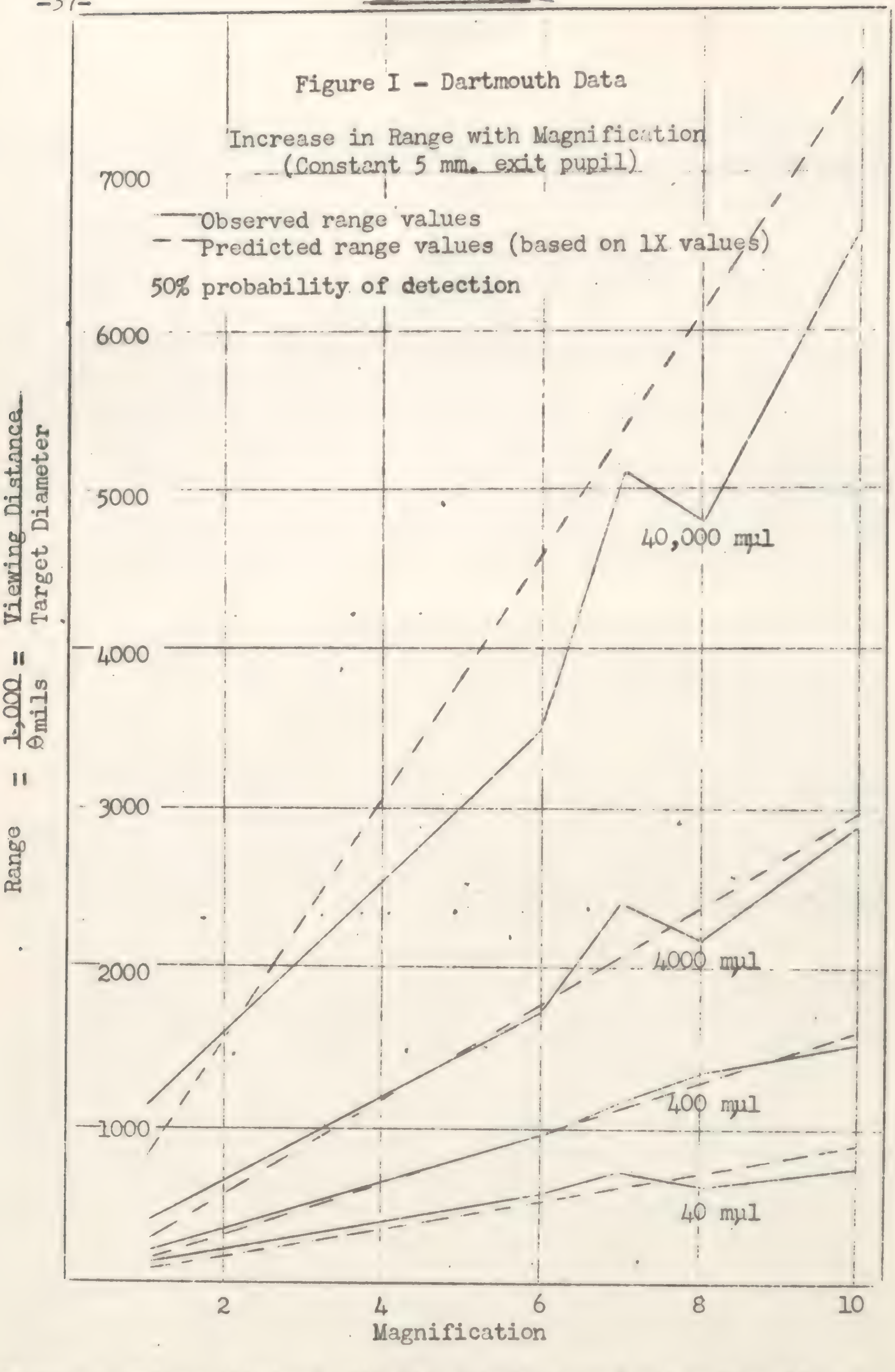
Miss Lillian Elveback

The general binocular testing program being carried out under Section 16.1 of NDRC has been described in the Minutes and Proceedings of the Vision Committee meeting of 16 June 1944. At that time, preliminary results of the studies made at the Dartmouth Eye Institute were presented. Since that time the final results have been prepared and have been presented in the final report, OSRD Report No. 4433.

The following graph is included here in order to correct the preliminary data presented in June. The figure shows that, when all physical factors, such as pupil size and transmission of the binocular, have been accounted for, the increase in range which is to be expected with increasing magnification is attained, within experimental error, and held throughout the range of magnification from 1X to 10X. The data accumulated at Dartmouth College does not show that difficulties connected with looking through an instrument or in centering the exit pupil on the pupil of the eye, and unsteadiness of holding, enter as first order effects in decreasing the range below that predicted on theoretical grounds.

The Dartmouth data show that for observers standing on a steady platform, without additional support, and holding the binoculars by hand, in the absence of atmospheric haze to diminish the contrast of the target, that range does increase linearly with magnification up to 10X.

Further data, accumulated at Brown University, under Contract OEMsr-1229, show binocular gains in range which are appreciably below those given here, but do corroborate the increase in range with magnification up to 10X.



The range values obtained with the naked eye and natural pupil are shown. From these the 1X range values have been predicted supposing the observer to be using a dummy binocular of 1X magnification, 5mm. exit pupil, and 77% transmission. The predicted binocular ranges at each level are simply the product of these values and the magnification employed.

D. Procedure and Results of the Brown University Binocular Program

Professor C. W. Miller

The results already accomplished in the Brown binocular program are outlined. The purpose of the program was to study the gain to be achieved in night vision by the use of binoculars. Dark circular discs were projected on a faintly illuminated screen, and the probability of detection under varying conditions was studied by a panel of twelve visually acute observers. In all of these studies the observers were standing upright, holding the binoculars without any direct support. The necessity of scanning was held to a minimum by locating all targets in one or another of six possible possible positions on the screen.

1. Exit pupil studies. The results are shown in graphs of relative range vs. exit pupil diameter for three levels of illumination, 40, 400, and 4000 ml. (1.6, 2.6, and 3.6 log units). No certain evidence was obtained of a gain with increased exit pupil beyond the pupillary diameter of the eye. For smaller exit pupils the effectiveness of the instrument falls off quite closely to the manner which would be anticipated from the decreased illumination. The most striking feature of these measurements is the fact that the decreased illumination resulting from the smaller exit pupil carries with it the corresponding gain in sensitivity from higher dark adaptation.

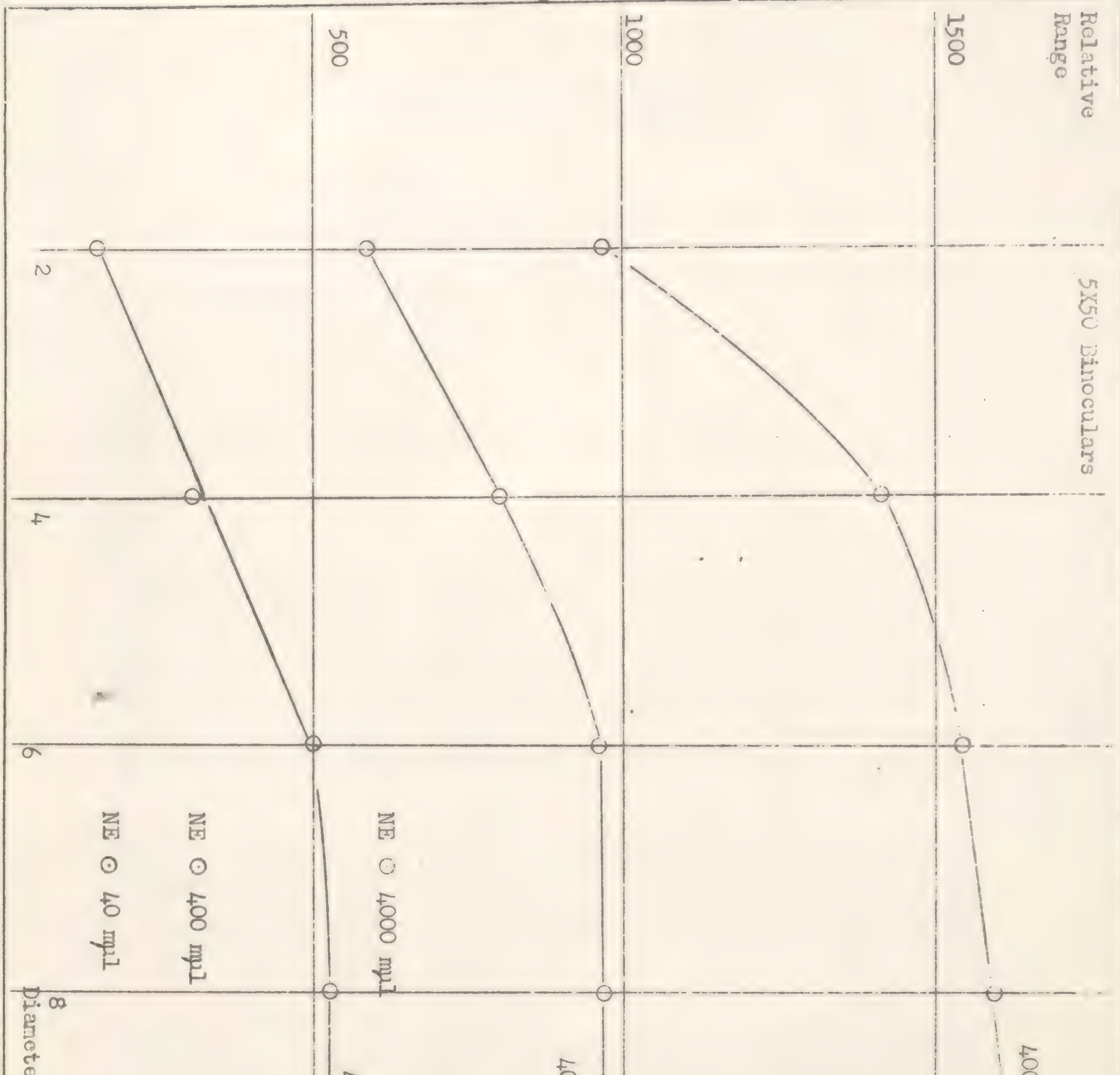
2. Naked eye studies. Naked eye studies were made with 100% contrast at the 0.6, 1.1, 1.6, 2.6, 3.6, and 4.1 levels. Log relative range is plotted vs. log background brightness in Fig. 3. Except for the lowest and highest levels the graph is linear, and can be well represented by the equation

$$\log R = 0.286(6.358 + \log B).$$

Failure of complete spacial integration is indicated at the lowest level. The range at the highest level is greater than would be expected from the linear relation, probably due to the increasing importance of cone vision and the decreasing role played by dark adaptation.

3. 50 mm. series. Fig. 3 exhibits also the relative range for 5x50, 7x50, 10x50, and 14x50 binoculars. All were studied at the three intermediate levels, and the 5x50 observations were extended to the 0.6 and the 4.1 levels. With 100% contrast, failure of complete spacial integration is apparent only at the 0.6 and 1.1 levels except with the 14X instrument, where it sets in at the 1.6

Figure II


Relative Range
1500
1000
500
5X50 Binoculars
2
4
6
8
10
Diameter of Exit Pupil (mm.)
NE ⊙ 4000 mμl
NE ⊙ 400 mμl
NE ⊙ 40 mμl
4000 mμl
400 mμl
40 mμl

CONFIDENTIAL

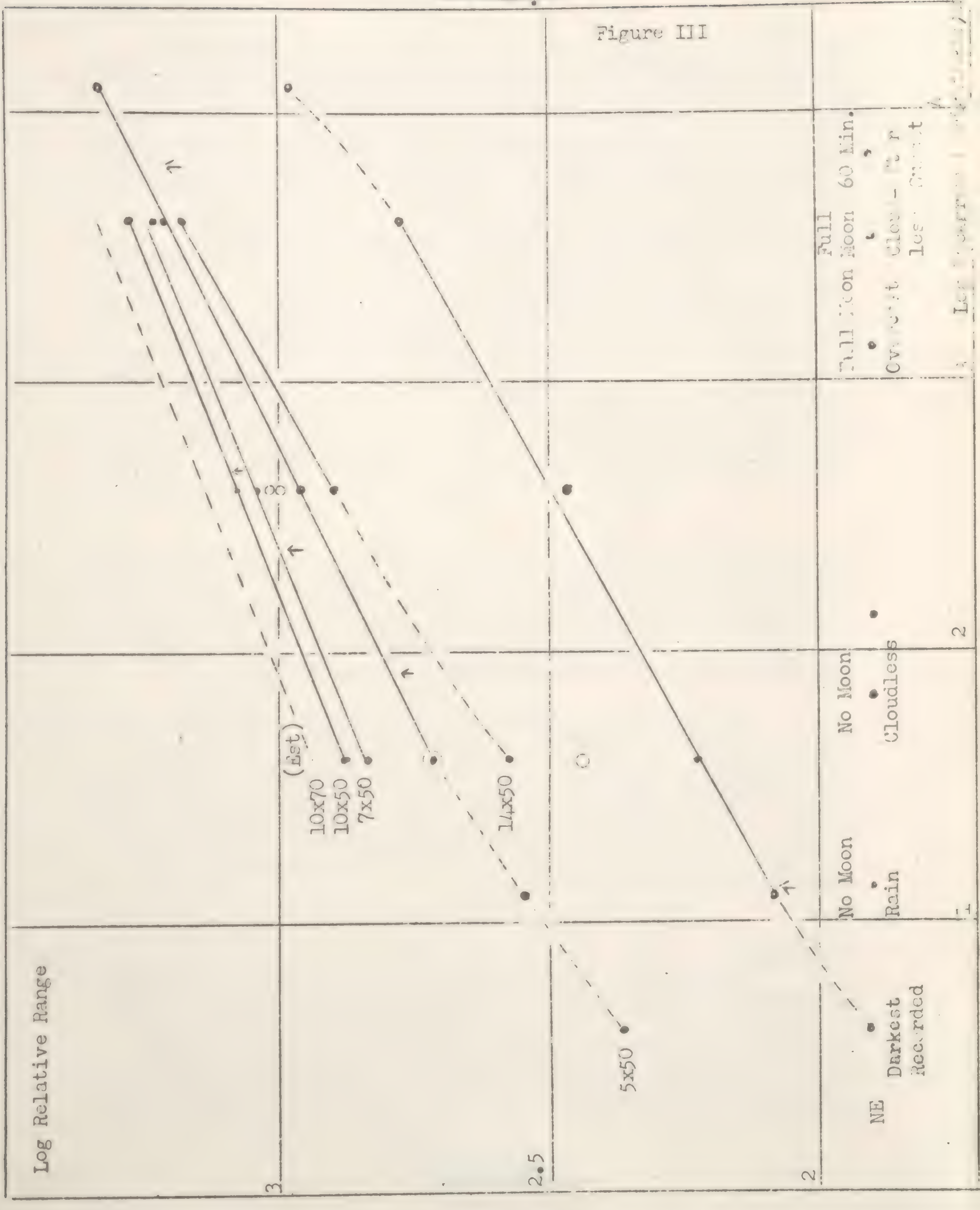


Figure III

level. In each graph arrows indicate the position of the 10^{-4} steradian target at which failure of such integration might be anticipated in the light of previous experiments.

With 40% contrast, failure of integration is marked at the 1.6 level and probable at the 2.6 level for both the 7X and the 10X binoculars. With 100% contrast, the binocular gain increases uniformly with decreasing illumination. An exception is the case of the 14x50. This trend is exhibited in the following table.

Power / Ill. Level	1.6	2.6	3.6
5X	3.1	3.1	2.7
7X	4.1	3.7	2.82
10X	4.5	4.1	3.17
14X	2.25	2.7	2.5

The most likely explanation for the low gain at the 3.6 level is a failure of temporal integration. It is interesting to note that the failure of integration with 40% contrast at the 1.6 level is such as to cancel the advantage of the 10X binocular over the 7X under those conditions. This is indicative of what may be expected to occur much more extensively at still lower levels of illumination.

4. Effects of reduced contrast. Studies were made at certain levels with contrasts as low as 5%. Except for very low contrast targets the results support the belief that detection is determined by the product $B\Omega$. An exception was the apparently reduced chance of detection of low contrast targets at the 3.6 and 4.1 levels. It is considered probable that these effects are related in some way to a failure of integration associated with unsteadiness in holding binoculars.

Discussion:

Comdr. Ballard emphasized that the Services need immediate information on which to base decisions concerning problems of design of all types of optical devices. Results of laboratory tests are not useful unless the material is synthesized and can easily be applied to specific problems. One solution for quick answers would be practical field tests with a number of observers making repeated observations for a period of a few weeks. Dr. Hecht pointed out that

setting up a reproduceable field test in a short time is very difficult, but that a few intelligent observers rendering good subjective judgments under such circumstances would be very effective. Dr. Dunham agreed that if three binoculars, previously screened by laboratory tests, were tried out in this manner for varied conditions of viewing, any significant differences between them would become apparent.

Dr. Marquis suggested that areas of remaining disagreement on problems of design be determined before undertaking large scale field tests or further research. Several members agreed that laboratory tests have produced enough material to recommend the best choice of available instruments, but that these data must be compiled and presented in practical terms. Spot tests and small specific experiments could then be made if further data were needed. Comdr. Ballard stated that needs of the Services could be fairly clearly outlined and recommended the appointment of a working committee to (1) evaluate and interpret present data, (2) determine the need for further data, and (3) examine the means for securing it. It was agreed that the Chairman appoint such a Committee.

13. VISUAL THRESHOLDS OF POINT SOURCES IN FIELDS OF BRIGHTNESS FROM ZERO TO DAYLIGHT

The following abstract of a report by R. Tousey, H. A. Knoll, and E. O. Hulburt was prepared and presented by Dr. Hulburt.

Experimental data at the Naval Research Laboratory for several observers show that for the unaided eye the visual threshold illumination f at the eye from point sources in fields of brightness b is in agreement, within a factor of 3, with the relation

$$f = 10^{-10} (1 + b)^{\frac{1}{2}}, \qquad (1)$$

where f is in foot-candles and b is in millimicrolamberts (mμ l). (1) is valid for b from zero to 4×10^9 mμ l. (1) is approximately true for sources and fields of the spectral quality of daylight, skylight, moonlight, starlight and tungsten light above a color temperature of about 2700 K. (1) is not true for sources and fields that appear considerably colored to the eye.

The illumination f at a distance r feet from a point source of candle power c candles is

$$f = cr^{-2} e^{-Br}, \qquad (2)$$

where B is the attenuation coefficient of the atmosphere. From (1) and (2) one obtains

$$re^{Br/2} = 16.6c^{\frac{1}{2}} (1 + b)^{-\frac{1}{4}}, \qquad (3)$$

for r in sea-miles, c in candles, b in mμ l and B in sea-miles^{-1}.

For a given r the values of c given by (3) are threshold values for normal good observers with unaided eyes. Among a group of normal "good" observers there are usually some who are exceptionally good and some who are not so good. For positive signalling with unaided eyes the values of c of (3) should probably be multiplied by a number between 10 and 100.

To illustrate the meaning of the foregoing statements, (1), and hence (3), states that a point source of the brightness of a seventh magnitude star is at the threshold of visibility for the unaided eyes when viewed against a scene of brightness 20 mμ l which is about the brightness of woods or the sea on a clear moonless night. Multiplying the brightness of the point source by 100 brings it up to that of a second magnitude star, as Polaris. This is considered

to be the brightness necessary for positive signalling. Under good conditions, as on land with no disturbance and plenty of time, positive signalling can, of course, be accomplished with less light than that given by the factor 100. Under less good conditions, as on a ship or airplane and with little time, positive signalling may require more light than that given by the factor 100.

Another illustration is that (3) states that the threshold range of a 100,000 candle power searchlight is 8.2 sea-miles in daylight for $b = 100$ candles foot^{-2} and $B = 0.356$ (a "seven-tenths" atmosphere). This is in agreement with Naval tests at sea.

10. DESIGN AND DEVELOPMENT OF 7X50 STANDARD NAVY BINOCULARS (Continued)

The following paragraph is continued from Lt. C. G. Hamaker's report on pages 23-25.

Various requests have come from the fleet for the development of higher power binoculars to be used for aircraft recognition purposes. At the present time, the Bureau of Ships has under development 8x60, 10x70, 15x60, 15x63, and 20 power binoculars. The 20 power binocular is now in production and is being placed aboard larger vessels for shore bombardment purposes and for general recognition uses. This binocular is a design similar to a captured 20 power binocular; however, the instrument has been made completely watertight and will be gas charged to three pounds per square inch. Various other additional features have been incorporated in the design, and it is believed that this instrument will, in the future, take the place of the ship's telescope. The instrument is 20 power, with 120 mm. objectives, 6 mm. exit pupils, and 3° true field (60° apparent field).

ABSTRACTS

53. TRAINING AIDS MANUAL

Great Britain, Air Ministry, A.P. 2655, Volume 1, July and November 1944, 117pp. (restricted).

This volume is issued in parts to provide instructional and servicing personnel a convenient reference to information on the use of all training aids with the exception of radar trainers. There are four main sections headed, respectively, General, Armament, Navigation, and Signals. The following chapters which have some vision interest have been issued already.

SECTION I, Chapter 1 - Anti-submarine attack training film provides practice in judging the moment for release of depth charges.

SECTION I, Chapter 2 - Ship recognition instructor, a trainer designed for use in small rooms which provides an optical means of viewing models (ships, aircraft, tanks, etc.) under varying degrees of illumination against a background of sky and different seascapes. A number of observers can use the trainer at the same time.

SECTION I, Chapter 5 - Model airfield with airfield lighting, Mk. II. A circular model, seven feet in diameter, represents an airfield, with surrounding relief of countryside. A lighting system arranged underneath the model simulates the appearance of airfield lighting when viewed from the air at night. Pupils can thus be familiarized with the appearance of the airfield lighting system before their first night flying.

SECTION I, Chapter 8 - Models for training in recognition and aiming.

SECTION I, Chapter 12 - Modified Haskard range, a model landscape which can be used for a variety of purposes including training observers in pin-pointing their position, training in air observation for ground artillery, training in air reconnaissance under ground battle conditions, etc.

SECTION I, Chapter 15 - Night simulation attachment for epidiascope. The attachment enables the view (an aerial photograph) on the screen to be varied to represent different conditions of moonlight and haze, and can be used for briefing and training air observers.

SECTION I, Chapter 16 - Fighting control trainer, an instructional fuselage set up in a hangar, with silhouette boxes placed on the walls in various positions, used to train aircrews in a standard system for reporting the position, type, and range of attacking enemy aircraft.

SECTION I, Chapter 17 - Hunt aircraft recognition trainer (static) provides a means of representing the altered aspects of an aircraft due to the variation in range, altitude, and condition of visibility to a number of pupils at the same time.

SECTION I, Chapter 18 - Hunt aircraft recognition trainer (mobile).

SECTION I, Chapter 20 - Shadowgraph recognition trainer (C.G.S.)

SECTION I, Chapter 21 - Day-Night flying, a system of simulating night flying conditions during day time by the use of filters which transmit only light from special lamps on the flare path or in the cockpit to illuminate the instruments.

SECTION I, Chapter 25 - Night vision trainers. Used to assist individuals in practicing parafoveal vision under conditions of low illumination. The pupil sits at one end of a wooden table and follows the irregular lateral movements of a model aircraft target with his gunsight. A summation device, which records the total proportion of time during which the sight has been accurately trained on the target, provides a means of comparing the performance of the various observers and of gauging the improvement of an individual. In spite of the fact that this trainer depends upon the use of a gunsight, it is not intended to give training to gunners in night marksmanship, but to increase the night visual acuity of all aircrew under night conditions.

SECTION II, Chapter 1 - Edmondes' deflection trainer. Developed to train pilots in deflection aiming combined with range-judging and recognition, this trainer consists of a Link trainer, to which has been fitted a reflector gunsight and a spotlight operated by the firing button, and a trolley which carries a model aircraft at the top and a graph on which the spotlight registers the error of aim.

SECTION II, Chapter 4 - A.M. bombing teachers (all Mks.) For instruction in the use of bombsights, for practice in dead reckoning navigation, and for practice in finding wind speed and direction without an aircraft. From a projector mounted at the top of a building a moving photographic image of a tract of country is projected on the white floor. Between the projector and the floor is a platform that accommodates the pilot and bomb aimer, positioned as in an aircraft with a bombsight and representation of the necessary flying instruments.

54. NIGHT VISION TRAINER

Great Britain, Air Ministry, A.P. 2655A, June 1944, 31pp. (restricted).

Detailed description of the trainer referred to in SECTION I, Chapter 25 above, with instructions for use, standard exercises, and directions for installation and servicing.

55. USE OF TANK COMMANDER'S VISION CUPOLA IN DEFENSE AGAINST AIR ATTACK

Armored Board, Fort Knox, Kentucky. Project No. 446-2, 30 October 1944, 5pp. (confidential). Also: Army Air Forces Board, Orlando, Florida, Attack on tanks by aircraft. Project No. 3670H373.1, 7 December 1944, 7pp.

Skip bombing and low-level bombing attacks were made on (a) a single stationary tank, (b) a single tank moving in a straight line, and (c) a platoon of tanks taking evasive action, to determine the value of the vision cupola in defense against such attacks and to evolve a tactical doctrine as a result of the test. Concerning the vision cupola, the report concludes that it affords good all around vision permitting hostile aircraft to be easily spotted at long ranges.

56. HETEROPHORIA

Scobee, Richard G., The Air Surgeon's Bulletin, 1945, 2, 38-9(February). (restricted).

A discussion of the nature of heterophoria is related to the problem of testing. The variability of heterophoria measurements is attributed to the difficulty of elminating innervational factors influencing the eye. Various tests of muscle balance presumably give varying results because they eliminate different innervational factors in varying amounts. The stimulus most easily eliminated is fusion; distortion, displacement, and cover tests are the three main types designed for this purpose. Tests are described and criticized. The screen and parallac test (cover) is the most accurate, but more time-consuming and more difficult to perform than the screen-Maddox rod test (distortion and cover). A high (0.81) correlation coefficient between the two tests at 20 feet leads to the recommendation that flight surgeons examining large groups of men use the screen-Maddox rod test, keeping the screen and parallax test in reserve.

57. A RADAR TRAINER AND FLASH-READING METHOD FOR OPERATORS OF THE PLAN POSITION INDICATOR

Lindsley, Donald B., Applied Psychology Panel, NDRC, Project SC-70, NS-146, Research Report No. 14, 23 December 1944, 17pp. (confidential).

An optical-mechanical radar trainer and a flash-reading method of training in plot reading and target location are described. The trainer simulates the scope presentation of the Plan Position Indicator and momentarily flashes target echoes or signal blips whose locations may be read in terms of either polar or grid coordinates. The flash-reading method stresses speed and accuracy of performance and is organized so as to train the radar operator and plot reader to perform at levels of proficiency expected in actual combat operation. The trainer and flash-reading method permit standard conditions of training and objective methods of scoring proficiency during training.

Experimental studies of the use of the trainer and flash-reading method are reported. Sixty men were trained in reading blip locations for ten days and showed an average improvement in accuracy of approximately 100 per cent. Learning curves show that both good and poor operators make marked improvement with training. The method is shown to have good reliability as a performance measuring and training device. Performance on the trainer shows fairly high correlations with oscilloscope operator tests.

58. A SURVEY OF VISIBILITY LIMEN DATA

Langstroth, G. O., J. L. Wolfson, H. F. Batho, E. H. McLaren, M. J. McLeod, and W. G. Wong., University of Manitoba, Department of Physics, Project C.E. 128, 18 January 1945, 31pp. (confidential).

A knowledge of the limiting conditions under which objects can be seen by normal observers (i.e. of visibility limen data) is of fundamental importance in a wide variety of problems. The numerous limen data to be found in the literature exhibit extremely wide divergences. In this report, (a) certain relevant features of the operation of the visual mechanism are discussed, (b) an outline of present knowledge of the dependence of limen data on the experimental arrangements used in obtaining them is given, (c) a survey of available limen data is made, and (d) a compilation of limen values based on those data selected as most suitable for general engineering use is presented.

The most suitable data for general engineering use are those obtained using unrestricted binocular vision and an appropriately long

exposure time with a target situated in a large surround of comparable brightness. The compilation of limen values obtained under these conditions is considered to represent the best that can be done with available data, but further investigation is highly desirable.

The scatter in limen determinations is descriptive of a definite property of the visual mechanism. There is no single value for the contrast of a target of given angular size at a given brightness level below which the target is never seen and above which it is always seen. This holds even for a single observer over a short period of time. For practical applications it is important to know not only the average limen value, but also the ditribution of individual values about it. These features should be known for a group of observers sufficiently large to avoid excessive 'sampling errors'. A statistical analysis of the data at present available indicates that the contrast of a target should not exceed 1/3 to 1/2 of the average limen value if the purpose is to conceal. If the purpose is to reveal, it should not be less than 1.5 to 2 times the average limen value. In the past these considerations have received less attention than they merit.

59. NIGHT VISION INDOCTRINATION

Iannone, A. B., and Nestor J. Totero, The Air Surgeon's Bulletin, 1945, 2, 44-45(February). (restricted).

A discussion of the need for a night vision training program in the AAF including suggestions for subject matter and demonstrations.

60. SUNLIGHT HARMS NIGHT VISION

Hecht, Selig, The Air Surgeon's Bulletin, 1945, 2, 45(February). (restricted).

This article presents briefly the results of experiments conducted at Medical Field Research Laboratory, Camp Lejeune, reported to the Vision Committee on 12 October 1944 (Proceedings, sixth meeting, pp. 16-18).

61. TESTS OF JET PAINT NIGHT CAMOUFLAGE

U. S. Naval Air Station, Patuxent River, Maryland. Project No. TED NO. PTR - 2553, 1 September 1944, 16pp. (confidential).

NDRC glossy black lacquer and "Jet" glossy black lacquer were compared in laboratory and model scale tests. "Jet" glossy black lacquer, glossy sea blue lacquer, and non-specular black paint all-over camouflage finishes were applied to three SNJ's for flight tests and for investigation of the practicability of application and amount of maintenance required. The report concludes: (1) As examined in the laboratory, the NDRC glossy black was slightly glossier and darker than the "Jet" glossy black. When applied to model aircraft and observed at night under one-point illumination, gloss and flash characteristics were found to be the same for both. When not flashing, however, the model painted with the "Jet" glossy black was observed to be slightly lighter and consequently easier to see against the night sky than was the model painted with NDRC glossy black. (2) "Jet glossy black lacquer is not so practicable a finish for field application and maintenance as is non-specular lacquer. (3) At night under the comparatively weak illumination of moonlight or of flares there is no appreciable and all-around difference in the visibility of the aircraft painted in "Jet" glossy black, non-specular black, and glossy sea blue. Flash, where it occurs, is of a low order, and differences in the reflectances of the three finishes are so slight as to have a negligible effect on their relative visibility. Much of the time throughout the flight tests the three camouflaged aircraft were equal in visibility. When there was a difference, however, observation data indicates the order of visibility to have been as follows: (a) Under a one-point source of illumination, such as the moon or one or more flares concentrated: the "Jet" black SNJ was least visibile and therefore the best camouflaged; the non-specular black SNJ was next lowest in visibility; the glossy sea blue SNJ was most visible. (b) Under multiple-flare illumination in which the flares were spread out, rather than concentrated: the non-specular black SNJ was least visible; the glossy sea blue was slightly more visible; and the "Jet" SNJ was most visible.

62. MANUAL FOR THE INSTALLATION AND ADJUSTMENT OF THE MULTIPLE PROJECTION EIKONOMETER

Imus, H. A., Applied Psychology Panel, NDRC, Project N-114, Memorandum No. 9, 10 October 1944, 67pp. (restricted).

This manual includes the complete description of the Multiple Projection Eikonometer, directions for its installation

and adjustment and suggestions concerning its maintenance. The main body of the report is concerned with the description, installation and operational test of the instrument, followed by suggestions for the general care of the Multiple Projection Eikonometer. A description of the test furnished by the instrument and a manual for its use are contained in OSRD Report No. 4050. Data on the validity of the test for Army height finder observers are included in OSRD Report Nos. 1789 and 1790. Similar data for Navy rangefinder operators will be available shortly.

63. RAPPORT SUCCINCT SUR L'ACTIVITE DES LABORATOIRES DE L'INSTITUT D'OPTIQUE

France. Institut d'Optique Theorique et Appliquee, Paris. n.d. (1944) 7pp. (classification not given)

A summary of research and development on the following subjects:

1. Visual acuity as a function of the pupillary diameter, brilliance, and contrast, for different observers. Results published in "La Vision dans les Instruments" issue of the Revue d'Optique.

2. Night focus. As the pupil diameter increases with decreasing illumination, the eye becomes myopic by about 1.5 to 2 diopters. Hyperopic eyes see better at night than normal eyes. The vision of emmetropic observers at night is improved about 25% by proper glasses.

3. Effect of food on time required for dark adaptation. It was noted that as a result of inadequate diet, especially in 1941 and 1942, the time for dark adaptation was almost trebled over what it was before the war for the same observers.

4. Exit pupil for night instruments should be at least 8 mm.

5. Effective light transmission of instruments. Two instruments with transmission factors of 0.50 and 0.80 will be equally good in daytime use; at twilight the latter will give a resolution 3 to 5 times the former; and at night the advantage is 1.5 times.

6. Night telescope with mirror eyepiece which presents an apparent field of $120^o \times 90^o$, objective 300 cm., magnification 20X, transmission 0.85. A fighter plane of 14 meters spread was observed against a moonless sky at a distance of 12 kilometers.

7. Telescope using phosphorescence for the detection of infrared search lights.

8. Methods for the measurement of scattered light in optical instruments.

9. Methods of surfacing glass for non-reflection and for front surface mirrors.

64. MIRE A CONTRASTE ET A DIMENSIONS VARIABLES D'UNE FACON CONTINUE

France. Institut d'Optique Theorique et Appliquee, Paris. n.d. (1944) 2pp. (classification not given).

Description of a visual target which is quantitatively and continuously variable in size and contrast. The image of the target composed of black and white stripes, is projected, and variable contrast is obtained by an interposed rotating white sectored disc.

65. SUMMARY X - REPORT NO. 3

Hqs. European Theater of Operations, USA. ALSOS Mission. 22 November 1944, 4pp.

This report summarizes the work described in Abstracts # 63 and #64.

66. COMMUNICATIONS DES LABORATOIRES DE L'INSTITUT D'OPTIQUE

France. Institut d'Optique Theorique et Appliquee, Paris. n.d. 35pp.

Following an introduction by M. Fabry, director of the laboratory, and a bibliography of 25 publications from the laboratory during 1941-44, four reports are presented: 1. Arnulf, A., Photometrie des Instruments et Lumiere Parasite, pp. 5-17. Study of the relation between scattered light, transmission, and loss of contrast, with a description of the apparatus used at the Institute. 2. Arnulf, A. and M. Francon, Etude Photometrique de Quelques Instruments. Influence d'un Traitement Diminuant Le Facteur de Reflexion des Surfaces, pp. 18-20. 3. Francon, M., Diagramme de Diffusion d'un Instrument, pp. 21-22. 4. Arnulf, A., La Clarte des Instruments Visuels. Influence des Variations du Diametre Pupillaire et de l'Effet Stiles-Crawford, pp. 23-35.